QUANTIFICATION OF THE EFFECTS OF HARVEST PRESCRIPTION AND ANNUAL VEGETATIVE RECOVERY ON SCENIC QUALITY OF PONDEROSA PINE AND COLORADO SPRUCE FOREST LANDSCAPES

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Scenic beauty is one of the many public benefits provided by the national forests. All forest management actions can be expected to affect this delicate resource. Treatment programs, whether designed to meet silvicultural objectives, watershed improvement, forage production, or timber harvest, have important effects on the scenic beauty of the forest landscape. The appearance of a timber stand may be dramatically altered immediately after treatment, but as a result of post-treatment rehabilitation efforts and/or natural vegetative recovery and change, the stand may regain or even surpass its initial scenic value.

Daniel and Boster (1976) have shown that the immediate impacts of forest management actions on scenic beauty can be precisely assessed in terms of public esthetic judgments. While immediate scenic impacts are an important consideration in the selection of alternative forest management plans, knowledge of the longer-term scenic consequences would be a valuable additional input to the selection process.

While some general long-term "recovery function" (sometimes referred to as "healing") is often assumed, there is little or no systematic evidence as to the nature or time course of this function. Predicting long-term scenic effects of forest treatments is a complex problem. Stands treated alike may differ in their initial condition so that response to treatment, rehabilitation efforts, and/or recovery over time may differ substantially. Thus, while some general trend of initial loss in scenic values followed by some recovery over time seems a reasonable expectation, it is by no means assured.

The purpose of the experiments reported below was first to assess the initial scenic impact of treatment on several forest landscapes, and then to determine the rate of recovery of scenic beauty values over time. Scenic

beauty was assessed by application of the Scenic Beauty Estimation (SBE) Method described by Daniel and Boster (1976). Photographic representations of forest study areas were judged by panels of observers and Scenic Beauty Estimates (SBEs) were computed for each area at several pre- and post-treatment periods. The first study traced the immediate and subsequent effects of a multi-product timber harvest on the scenic beauty of two forest stands. In the second study the scenic recovery of two experimental watersheds was assessed over a four year period.

The specific objectives addressed by these studies were to:

1. Evaluate and compare the scenic values of forest landscapes before harvest and after various harvest and post-harvest treatments.
2. Evaluate and compare the scenic value of two types of forest landscapes as affected by harvest and post-harvest treatments.
3. Determine the effect of annual vegetative recovery on the scenic beauty of treated forest landscapes.

EXPERIMENT I

The SBE Method was applied to assess the effects of a multi-product timber harvest on two forest stands. A ponderosa pine stand in northern Arizona (Apache National Forest) and a Colorado spruce stand in southern Colorado (San Juan National Forest) were evaluated before and after harvest treatment. Both stands were subjected to a variety of harvest and post-harvest treatments including saw-log and pulp-wood harvest and slash disposal. On some areas (but not all) on both sites, slash was disposed of by on-site chipping (see Sampson, et al, 1974 for a more detailed description). Pre-treatment, post-treatment, and one-year after treatment conditions were evaluated to determine short- and long-term effects on scenic beauty values for both stands.

Method

Color-slide representations of the two study areas were obtained by application of a fixed-point sample grid system. A north-south, east-west grid was mapped over each area and the grid-line intersections were marked by survey stakes. Each staked location served as the origin or viewpoint for a set of four color-slide photographs. The four slides taken from each origin were oriented at 90° intervals, with the orientation (compass heading) of the first photo determined by a table of random numbers ranging from 1 to 360. The origins and photo-orientations remained constant for the entire study--the four photo-orientations at each point were replicated before treatment, immediately after treatment, and again one year after treatment.

While a large number of sample points were initially located for each study area (36 plots for the ponderosa site and 46 for the Colorado spruce site), many of the sample points could not be used for the final study. Several unavoidable factors led to sample attrition: first, during the course of the study harvest plans were changed so that many locations originally sampled ("before" photos) were not harvested; second, the harvest operation obliterated a number of sample points by placement of roads and landings; third, a few color-slides were rejected after inspection because of poor photographic quality (blurred, over-exposed, etc.) or because of their inclusion of extraneous features (e.g., snow, plastic flagging, oil cans, etc.). By far the largest attrition was due to the first factor. As a result of all of these factors, only six sample plots in the pine study area produced a complete matched set of four pretreatment (Before), four immediate post-treatment (After), and four one-year post-treatment (One year after) slides. The spruce study area fared better, yielding a total of 20 completed sample plots.

From the available completed sample plots, each having four matched color

slides for all three study periods--15 three-slide sets (before, after, one-year after) matched for origin and orientation were randomly selected for each of the two study areas. These 90 slides (15 x 3 = 45 pine and 45 spruce samples) were scrambled into a random order for presentation to an observer panel.

The observer panel was composed of 29 volunteers from freshman-sophomore classes at the University of Arizona. The randomly-ordered color-slides were shown one at a time to the panel on a 2m. x 2m. daylight projection screen. A Kodak Carousel slide projector presented slides at an automatically-timed 8-second interval. Another Carousel projector, synchronized with the first, presented a small numeral on the screen next to the color-slide corresponding to the numbers on the observers' response recording sheets. Observers independently judged the scenic beauty of "the area represented by the color-slide", and recorded a number from the 10-point scenic beauty scale (Daniel and Boster, 1976) for each slide.

Results and Discussion

Ratings for each slide by each observer were subjected to the psychophysical scaling analysis described by Daniel and Boster (1976) and SBEs were calculated. Each of the 29 observers thus provided separate SBE values for before, after, and one-year after conditions (based on his/her judgments of the 15 slides in each condition) for both the pine and the spruce study areas. The ponderosa pine--before treatment condition was arbitrarily assigned as the origin or zero point for the standardized-difference SBE metric.

Mean SBEs (over the 29 observers and the 15 plots within each stand) are graphed for both forest study sites in Figure 1. It is evident from the graph that the ponderosa pine site was severely impacted by the harvest treatment. Scenic beauty values dropped a total of 35 units on the SBE scale. The Colorado spruce site, although initially judged lower in scenic value than the pine stand,

did not suffer a loss in scenic value as a result of harvest--instead there was a 15-unit improvement in SBEs immediately after harvest. Both sites showed some improvement over the year following treatment, but only the pine site showed any substantial change--a 21 unit improvement.

Statistical analyses confirmed the observations above. The interaction between study area (pine vs. spruce) and treatment condition (before, after, and one-year after) was significant, $F(2/56) = 5.47$, $p < .025$.

The effects of harvest treatments and post-harvest recovery, then, depended upon the initial characteristics of the site. In this study the ponderosa pine site showed an immediate and substantial reduction in scenic beauty as a result of the multi-product harvest. The spruce stand, while lower in scenic value <u>before</u> harvest, actually improved scenically after harvest treatment. Both sites improved in the year following treatment, but the pine site showed much more pronounced effects of vegetative recovery.

Studies of the relationship between forest features and judged scenic beauty (e.g., Arthur, 1977; Daniel & Boster, 1976; Daniel, et al, 1977) provide a basis for understanding the obtained pattern of results. It has generally been found that the major features (in ponderosa pine forests) affecting scenic beauty judgments are tree density and size distributions, vegetative ground cover, and the amount (volume) of downed wood. More open stands with substantial, vigorous ground cover and little or no downed wood are the most preferred. Very dense stands, offering little visibility, with relatively sparse ground cover and with large volumes of downed wood are the least preferred areas. If these same factors affected judgments in the present study --comparing a pine and a spruce stand--that would account for the higher values assigned to the pine stand. The spruce stand was generally more dense and had much more vegetation at eye level than did the more open pine stand. Because

the photographic sampling procedure is directed at representing the forest as it appears from "ground level" viewpoints within the forest (rather than from vistas or open meadow areas), the spruce stand presented few views where visibility extended for more than a few meters. This factor alone could have accounted for the greater scenic beauty values assigned to the ponderosa pine stand.

These initial differences in forest characteristics probably accounted for much of the difference in response to the harvest treatment. Apparently, reducing the density of the spruce stand, thus opening up more extensive views through the forest, produced a positive scenic effect. The pine stand was already relatively open and thus had little to gain by additional thinning. Further, because the proportion of large yellow pines, a positive scenic feature, (Daniel, et al, 1977) was reduced, the scenic beauty value would be expected to decline.

In spite of slash disposal efforts, including some on-site chipping, both stands showed additions to downed wood volumes as a result of the harvest treatment. Downed wood has been found to be the most important factor reducing scenic values in pine forests (Arthur, 1977; Daniel & Boster, 1976). While increases in downed wood probably contributed negatively to scenic beauty, apparently the positive effects of opening up the stand were sufficient to produce an improvement in overall value for the spruce stand.

The year of post-harvest recovery led to improvements for both sites, although only the pine site showed any substantial change from immediate post-harvest values. This improvement is probably attributable to the growth of ground vegetation, especially grasses. In addition to "greening" up the stand and covering skid trails and other ground disturbance, ground vegetation also tended to obscure some of the slash produced by the harvest. By reducing the

apparent amount of downed wood, some negative scenic effects were reduced.

The present study did not provide data regarding longer-term recovery of scenic values. However, it seems likely that the pine site, and even the spruce stand, would continue to show improvement with additional years of post-harvest recovery. The rate of recovery evidenced by the pine site in the first post-harvest year would probably not be matched in subsequent years. The expectation, then, is for more, but slower, recovery of scenic beauty values in succeeding years after harvest treatment.

EXPERIMENT II

The scenic recovery of two ponderosa pine landscapes was assessed over a four year period following treatment. Two treatment areas in the Coconino National Forest, Arizona were selected for study. In addition, an untreated site in the same National Forest was sampled to provide an index of seasonal variation over the same four-year period. The primary purpose of the study was to assess quantitatively the rate of recovery of scenic beauty values over an extended period after initial forest treatment.

Method

The two treated areas selected for study were experimental watersheds 14 and 17 of the Beaver Creek Experimental Watershed. Watershed 14 was cut in the Fall and Spring of 1970-71. It is a fairly homogeneous stand of ponderosa pine with some intermixed gamble oak. The treatment applied was an irregular strip cut -- irregular shaped clear cut strips averaging 60 feet in width were separated by leave strips thinned to 80 sq. ft./acre basal area. Slash was generally piled and burned in the clear-cut strips, and was lopped below four feet in the leave strips. Watershed 17 was a similar ponderosa pine/gamble oak stand and was cut in 1969. The resulting stand is very sparse (approximately 30 sq. ft./acre basal area), composed of scattered pines with substantial numbers of

interspersed oaks, generally clumped. Slash was mechanically piled in parallel windrows extending across the area.

Treatments for watersheds 14 and 17 were designed as experiments to determine watershed characteristics affecting water yield and quality. Turner and Larson (1974) can be consulted for more detailed descriptions of the two stands and their pre- and post-treatment conditions.

The control area (Mahan Park, Coconino National Forest) was also sampled during the course of the study. This area was selected because it resembled the experimental watersheds in their pre-treatment condition. The control site had not been logged or otherwise treated for over 20 years and was expected to maintain a relatively stable condition for the duration of the study, except for normal year-to-year variations due to climatic conditions.

Random walk color-slide samples (Daniel and Boster, 1976) were collected for both treatment areas and the Mahan Park control site during June and July each year from 1971 to 1974. A set of at least 50 slides was taken in each area each year. From the slide sets, 15 photographs were selected at random to represent each year for each forest area. For experimental purposes unrelated to the present study, an additional 135 slides from other pine forested areas were to be evaluated at the same time. Because the total number of slides to be presented (180 for the present study plus the additional 135) was too large for one observer panel to view comfortably, the total number of slides was divided into three sets of 105 slides each for presentation to three different observer panels. Each panel viewed five slides from each forest area for each year of study, along with 45 other slides. A common set of 15 slides was added for presentation to each of the three groups so that any difference between the panels could be assessed. Each of the three sets of 120 slides was scrambled into random order for presentation to three different groups.

Three observer panels of 20, 26, and 30 volunteer students from the University of Arizona judged each of the assigned 120 slides independently. The slides were presented at eight-second intervals. Each observer assigned each slide a rating from the 10-point scenic beauty evaluation scale. SBE values were calculated for each observer for each of the four years evaluated for each study area. The product-moment correlations between the SBEs for the constant set of 15 slides revealed no significant differences among the observer panels (rs were .43, .67, and .79 for the three pair-wise comparisons).

Results and Discussion

Average annual scenic beauty values (SBEs) for the two treatment watersheds, 14 and 17, and for the control area are shown in Figure 2. Both treatment areas were substantially lower in scenic value than the control area at the time of the first sample. This difference is reduced over the succeeding years as both treatment areas tend to increase in scenic value. Watershed 14 shows an improvement of 33 SBE units between 1971 and 1974, and for the last two years of the study period produced SBE values quite similar to those for the untreated area. Watershed 17, although already two years past treatment at the beginning of this study, shows a slight improvement of 9 SBE units between 1971 and 1974. This apparent trend toward scenic recovery is substantiated by the results of an analysis of variance; the interaction between forest treatment areas (WS-14, WS-17, and Mahan Park) and sample year (1971 through 1974) was highly significant, F (6/126) = 4.418, $p < .001$. Additional data for watersheds 14 and 17 were available for the years 1975 and 1976. These data are also shown in Figure 2. The trend toward scenic recovery can be seen to continue in the fifth and sixth years (to the eigth year past harvest).

The recovery function for the two treatment areas is complicated by the rather large year-to-year variation in values for the three study areas. Even

the untreated control area shows substantial change in scenic value from year to year. The pattern of variation is the same for the three areas, suggesting that annual climatic conditions are the cause of scenic beauty fluctuations. Even though photo-samples were collected at approximately the same time (by the calendar) each year, variations in the amount and timing of spring thaws, summer rains, and other factors affecting the condition of the stands and ground cover were sufficient to produce noticeable effects.

The effect of seasonal variations seems to be more pronounced in the treated areas, especially WS-17, than in the control. This may be attributed to two factors: the treated areas are more open, having 2/3 and 1/3 of the over story removed in WS-17 and WS-14, respectively; and the ground disturbance produced by treatment would tend to stimulate growth of ground covers that would not be expected in the stable conditions of the control area. Both of these factors would tend to make the treated landscapes more "responsive" to changes in moisture and other seasonal fluctuations - for example, in a wetter year, wild flowers, grasses, and other greenery would be very evident in the more open, treated areas leading to a general elevation in scenic beauty values. Greenery and vegetative ground cover have been shown to be important contributors to scenic beauty judgments (Arthur, 1977, Daniel & Boster, 1976). In a dry year, (when moisture is low in volume or late in coming) these same areas would evidence a more barren, "dead" looking ground cover and scenic beauty values would suffer. The untreated area would be much less responsive to these seasonal fluctuations, whether positive or negative, and therefore have more stable scenic quality.

Inspection of the results of this study, then, suggests that four years is sufficient to observe substantial recovery of scenic values after treatment. However, the four-year sample period is probably the <u>minimum</u>, because changes

are relatively slow in the southwestern ponderosa pine zones. Another factor is the rather large effect of seasonal variations, which can be expected to interact with the characteristics of the treatment/harvest procedure study. By observing the trend in SBEs over several years (or more) the effects of seasonal variations can be separated from more "permanent" recovery effects.

Overall, the studies reported here confirm that the effects of treatment on ponderosa pine forests follow a detectable time-based pattern (see Daniel and Boster, 1976). In particular, the initial effect of treatment is generally negative; scenic beauty may drop dramatically for the year (or several years) following treatment. Recovery can be expected, however, with progressive improvements in scenic beauty values over (according to this study) at least the next six years. Daniel & Boster (1976) suggested that some areas may "recover" to the point that their post-treatment values will exceed the pre-treatment condition. This notion is not directly testable by the present study as no pre-treatment values were available for either of the areas studied. However, the rather dramatic improvement for both areas over the four-year study period suggests that, after a few more years (up to 10 years post-treatment, perhaps) these areas may exceed comparable untreated areas (e.g., the control area Mahan Park). A long study period is required to detect changes because seasonal variations can be expected to introduce substantial variations in scenic quality, variations that will be related to moisture conditions and to characteristics of the treatment being studied.

CONCLUSIONS

The studies presented above offer quantified documentation of the effects of harvest treatment and post-harvest recovery on scenic beauty of forest landscapes. As Daniel and Boster (1976) and other have anticipated, the immediate

effects of timber harvests and other treatments requiring the cutting of trees and disturbance of the ground, are substantially negative in ponderosa pine forests. Over time, however, the landscape can be expected to recover toward its original scenic value, and perhaps to surpass its original value, although the rate of this recovery is not rapid and is substantially affected by year-to-year climatic factors.

The effects of harvest treatments on other types of forests--such as the Colorado spruce site studied in the first experiment--may not adhere to the ponderosa pine pattern. In the one instance investigated to date, the immediate effect of harvest treatment was to improve the scenic value of the stand. While this one case is an insufficient base for any firm conclusions, it does seem reasonable that some stands, perhaps even some ponderosa pine stands, could benefit from the application of appropriately designed treatments.

Recently, prediction models for forest scenic beauty have been developed (e.g., Arthur, 1977), which relate specific physical features of the forest to perceived scenic beauty. These models should provide guidance as to which treatments could produce positive scenic effects on forest landscapes, for both short- and long-term planning.

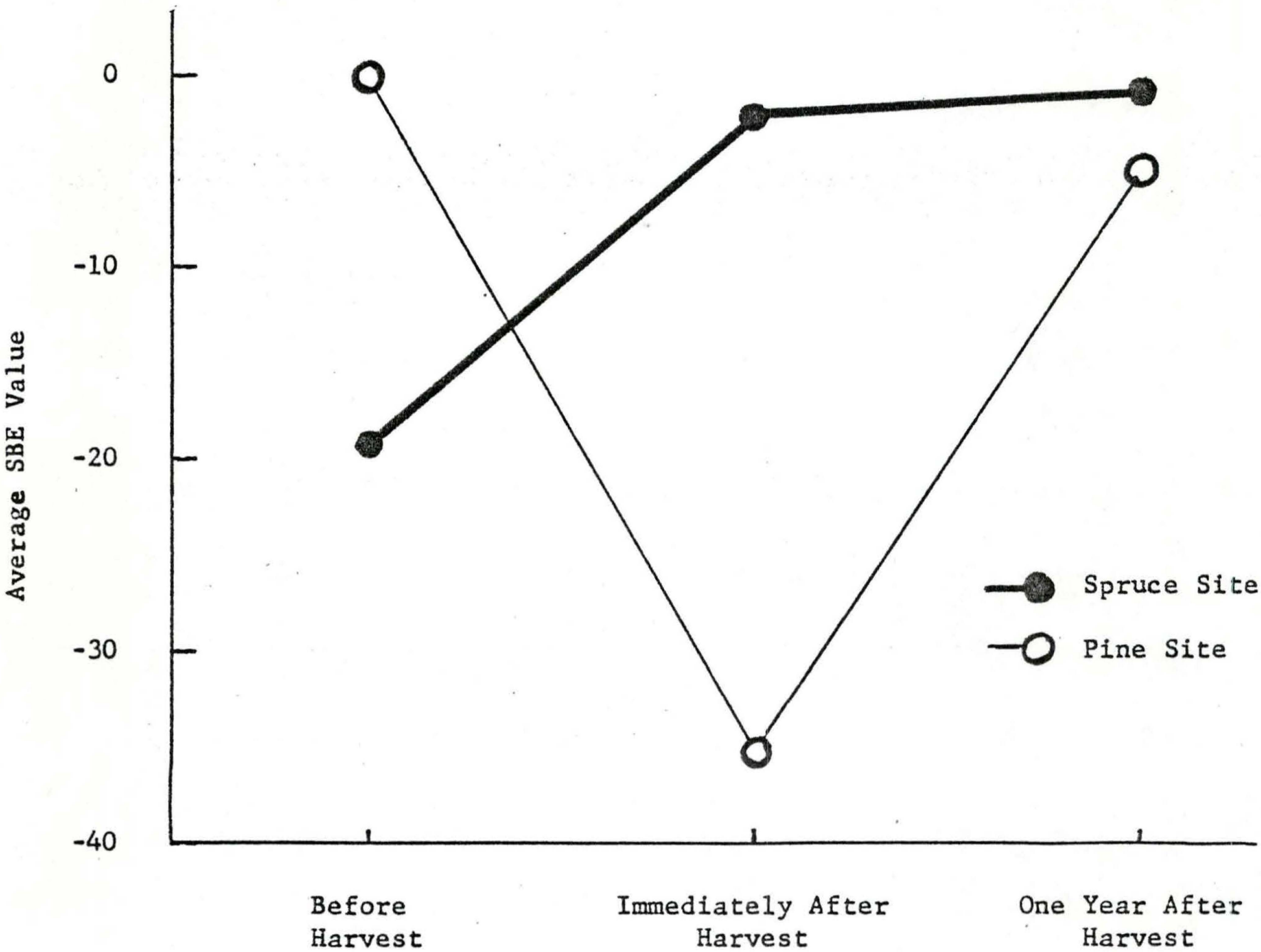

Figure 1. Average SBE values for two harvested forest sites

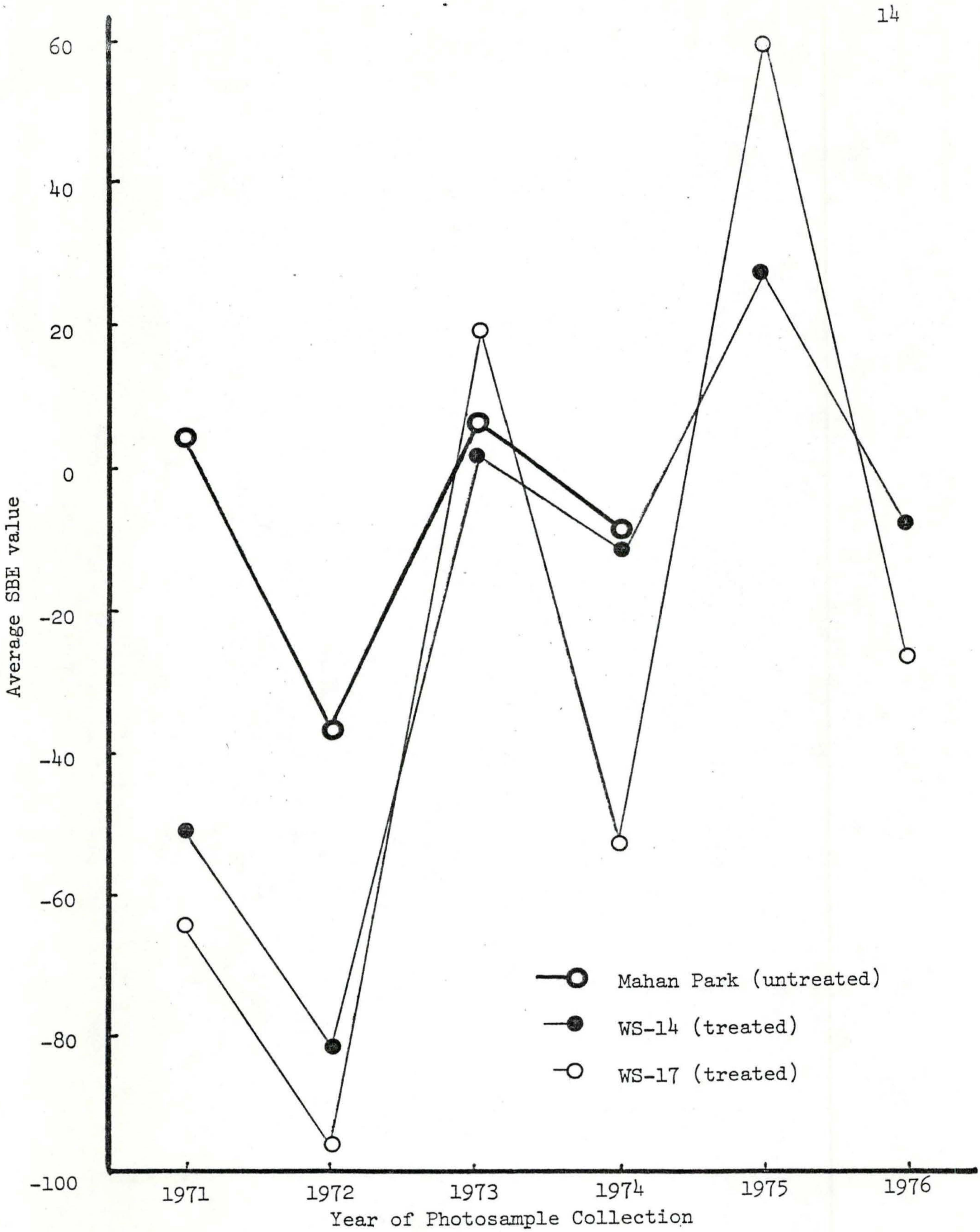

Figure 2. Average annual SBE values for treated and untreated forest areas

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